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PHILOSOPHICAL TRANSACTIONS.

Februar. 26. 1676.

77

The CONTENTS.

A Continuation of Mr. Boyle's Experiments, published in the next foregoing Tract, about Fluids contiguous to other Fluids. An Account of two Books: I. PALŒOLOGIA CHRONICA, &c. by Robert Cary, D. LL. II. A TOUCH-STONE for Gold and Silver-Wares, &c. by W. B. of London Goldsmith.

A Continuation of Mr. Boyle's Experiments published in the last Transactions; for which there was no room there.

IN the Winter time, and at other times also when the Air is cold enough, the figure, acquir'd by the surface of an Oil contiguous to the Water on one side, and the Air on the other, may be preserved from varying, and so may be at leisure observed by the Direction afforded by the following Experiment, which I devised for this purpose.

In Cold weather we took Essential Oil of *Anni-seeds*, whose property it is to coagulate in such weather, and having in a gentle warmth brought it to be fluid, we poured Exp. XIV it into a slender Viol more than half filled with Common water, that had been also a little warmed, that the Oil might not be too hastily reduced to its former state. This Oil being lighter than so much Water, and being poured on in a convenient quantity, had its upper surface somewhat concave, as that of the Water was; but the lower surface, surrounded by the Water, was very convex, appearing almost (for it was not perfectly) of the figure of a great Portion of a Sphere. This being done, the Viol was stoppt, and suffered to rest for some time in a cold place, by which means the Water continuing fluid as before, the Oil of *Anni-seeds* was, as I expected, found coagulated in a form approaching to that it had whilst in a fluid state; I say, approaching, because it was not easie to discern the exact

5 M.

Figure

Figure in the Viol I was fain to make use of: and I suspected, that the Oil grown consistent was become less convex than before; but the two *surfaces* of it gave it some resemblance in point of shape, but not of transparency, to a *Concavo-Convex Glas*; but yet much thicker in the middle than is usual in Glasses of the like breadth, employed for *Dioptrical Purposes*. And indeed (to give here this Advertisement once for all) I would not have you understand in too strict a sense, what my intended brevity, and some other Motives, make me deliver in naming the Figures of *Fluids*. For I confess, that if I were to write for a rigid *Geometrician*, especially if he were nice and critical in the Doctrine of *Conic Sections*, I should think my self obliged on some occasions to a greater Curiosity in naming the Figures of *Fluids*, than you will meet with in this Paper: But since I write but Notes, and design to give you rather Experimental hints, than *Geometrical* Determinations, I presume, that when you are once cautioned by a plain Advertisement, it may suffice for me to refer the *Fluids*, I describe, to such of the more known *Figures* as they seemed to be the least remote from, without troubling you or my self with maim'd Figures, or with *Spheroids, Conoids, Paraboloids*, and other hard words; which I the rather abstain from, not only because the Particulars, wherein my *Fluids* resembled them and differ'd from them, could not be intelligibly declared without many words; but because I observed the *Figures* themselves of the *Fluids* to vary, and sometimes considerably too, according to Contingent circumstances. And for this Reason also I will not persuade you to expect, that the event of every Trial, you shall make of these Experiments, will be precisely the same with the event of mine. For by reason of those contingent Circumstances, I dare only speak Historically of these Experiments, and, without pretending that they shall always uniformly succeed, content my self to relate *bonâ fide*, what Trials have been made, and what happen'd to me thereupon, not despairing, that this variation it self of Events according to Circumstances may be Instructive.

But to return to our lately mentioned *Oil of Anniseeds*, 'twas worth observing, how great a difference there was between the dull reflection it made when 'twas coagulated, and the fine reflection it had made whilst 'twas a Liquor. The later of which

Reflections

Reflections brought into my mind, how vivid the reflective power of some *Fluids* is in comparison of that of the generality of Solid bodies, of which there is scarce any, if there be any at all, that is observed to have a stronger Reflection than clean *Quicksilver*; and yet (to add that upon Exp. XV. the by) I have sometimes found, that this it self may be increased by the addition of a Liquor. For having observ'd, as I elsewhere note, that *Quicksilver*, and Rectified *Oleum Petrae* are, the former of them the heaviest, and the later the lightest of all the visible *Fluids* that are yet known to us, or at least to me; and having also observed the later of them to be considerably reflective, I had the Curiosity to try among other things, that related to them, the following Experiment. Some (Distill'd) *Quicksilver* being put into a small Viol, and held in such a posture, that the incident Light was strongly remitted to my Eye, I slowly put to it some *Petroleum*, that being well rectified was very clear, and observed, that, as this Liquor cover'd the *Quicksilver*, there was at the Imaginary Plain, where they both confined, a brisker Reflection than the *Quicksilver* alone had given before; whether this increase of Reflective power proceeded from any thing produced upon the confines of the two Bodies, or from some *Ethereal fluid* that slip'd in there, I have above declined, and shall now forbear, to examine: But on this occasion it will not be amiss to take notice, that either the surface of the Air it self, as thin and yielding a *Fluid* as it is, or the surface of a Solid, contiguous to included Air, or some interposed subtile matter, may reflect the Incident beams of Light more strongly than most men would expect. To this purpose I remember, that a Curious Person having one day brought me a couple of Rarities, which he told me were two pieces of a solid, but transparent, body, that he had casually found; in one of which there was a *Pearl*, large, round, and orient, and in the other a less perfect one; and having desired my Opinion, whether they were considerable enough to be presented to the King: I, after I had sufficiently view'd them in differing Positions, and especially against the Light, asked him, whether he were sure the included bodies were *Pearls*. To which when he answer'd, that his Eyes permitted him not to doubt of it, especially because he knew of no other Gems nor Stones, that had so strong and fine a Reflection; I replied, that I thought they might be only bubbles

of Air, casually intercepted in the viscous matter of the containing Bodies, (which I supposed, upon good grounds, to have been once somewhat *fluid*,) before it came to be hard; adding, that His *Majesty*, who was Critical in these matters, might probably have the Curiosity, I had, to have the worst of them broken, to be satisfied what kind of bodies the included were. Hereupon, to content me, one of them was open'd, and that which had appear'd a *Pearl* was found to be but a Cavity, that contain'd no grosser substance than Air. And I have by me a well shap'd piece of *Glass* of a good thickness, with an *Aereal bubble* in the middle, which by some qualities, particularly its *Pear*-like shape and vivid reflection, does not ill resemble a fair, though not *Orient, Pearl*. But in such like Observations, the Position of the Eye, and that wherein the Body receives the beams of Light, may be very considerable. For I have by me a small Stone (with which I have puzzled the Skilful *Jeweller* of a great Prince to determine what kind of *Gem* it is) that being laid flat upon ones hand, or a piece of Paper, and lookt on directly downwards, looks almost like a piece of common *Glass*, and is transparent: But if the Eye be so placed, that the Incident beams of Light, by whose Reflection 'tis seen, fall with a convenient degree of obliquity upon the Stone, it makes an exceeding pretty shew, sometimes appearing like a fine *Opal*, and sometimes not very unlike an *Orient Pearl*.

It may not be altogether impertinent, and at least, for the Novelty of the way of Trial, it will not probably be
 Exp. XVI. displeasing, if I here mention an Attempt to try, whether, when the Rays of light rebound from bubbles environ'd with an uniform Solid body (which case is somewhat differing from that of Bubbles look'd upon in an exhausted *Receiver*,) the Reflection be only, or almost only, from the grosser Particles of the Air, and not also from some Subtile matter harbour'd, as well as they, in the same Cavities? But to bring this question to Trial, seem'd difficult enough, because it is so, to include very rarified Air in a consistent body, *diaphanous* enough to let its reflection be easily observed. To compass this,
 * *In the use of Experiment.* I thought upon the following Expedient. We made, according to the easie direction * elsewhere given, *Philosophy.* (for other purposes,) a competent quantity of a

Resinous or *Gummy* substance, that looked like high colour'd
Amber,

Amber, but was easie to melt. This we put into a deep round Glass with a wide mouth, and held it by the fire-side in a moderate warmth, till it was brought into a *fluid* state; then we transfer'd it into one of our *Pneumatical Receivers*, where we presum'd, that this Temporary Liquor would, as well as Liquors that are constantly such, disclose *Aereal bubbles*, when the pressure of the Air was withdrawn from it; and accordingly having caused the *Air* to be pump't out by degrees, we found, that store of Bubbles appear'd at the top of the Liquor, and made there a copious Froth, many of them being, by reason of the *viscosity* of the Fluid, very large, and divers of them, because of the Nature and Texture of it and the Thinness of the films, being adorn'd with the colours of the *Rainbow*, whose vividness made them pleasant to behold, and suggested to Us some *Optical* Considerations. But notwithstanding this Froth, I caused the pumping to be continued, that those Bubbles that had most of common Air in them, and which therefore are wont to rise first, might get to the top, and the subsequent Bubbles might meet with more resistance from the Liquor still tending to grow cold, and so might be the more expanded, and yet kept from emerging by the concretion of the *Resinous* substance; and answerably to this we found, that, when this Substance had resumed its consistent form, there were intercepted, between the upper and the lower *surfaces* of it, some Bubbles that were not small, which yet had a considerable Reflection, notwithstanding the small quantity of the grosser Particles of the Air, that may be suppos'd to be contained in Bubbles so very much expanded, (perhaps so, as to exceed some hundreds of times their former Dimensions.) I might add, that by letting the outward Air into the *Receiver*, the Air in divers of the formerly mention'd large Bubbles, at the top of the Glass, was too much rarified to keep them from being broken by the pressure of the returning Air. But I am sensible, that, in what I have said of the Reflective power of the Air, I have already too far digressed, and therefore I shall step into the way again, and proceed to other Observations.

Water being so considerable a Body here below, I thought, it would be worth while, to endeavour to observe its *Surface*, when contiguous to other Fluids than *Air*, and, if it were possible, when surrounded by them. For though

Exp. XVII

tis

'tis taken for granted, that the falling drops of *Rain* are spherical, yet their descent is so swift, both by reason of their Gravity in respect of the Air, and the height from whence they fall, that I fear men have rather supposed than observed that their figure is Spherical; which will be the more questionable, if it be true, which is vulgarly thought, that *Hail* is but *Rain* frozen in its passage through the Air. For 'tis evident, that the grains of *Hail* are frequently of other figures than truly orbicular. But because there may another possible Account be given of this Irregular Figuration of *Hail*, I shall not insist on this *Phenomenon*, but proceed to what I tried about the *Surface of Water*; of which I found it the more difficult to make Observations, because that Liquor will readily mingle both with *Spirit of Wine* and with *Oil of Tartar*, and with other Liquors that are analogous to either of these.

The *Surface of Water* may have differing Figures, according as 'tis totally incompass'd with *heterogeneous fluids*, or, as 'tis only in some places contiguous to one or more of
Exp. XVIII. them. In the former case we found it not so easie to make an Observation, both because, that, as I lately noted, we know not of any two Liquors (setting *Mercury* aside) that will not mingle either with one another, or with *water*. And because also our *Oil of Guajacum* it self, though heavier than *Water*, would not be serviceable on this occasion, in regard of its being of so deep a Red, that the figure of the *Water* inclos'd in it could not be discern'd through it; wherefore I made use of Chymical *Oil of Cloves*, as being somewhat, and but a little, heavier in *Specie* than *Water*, so that some drops or smaller portions of this last nam'd Liquor would be almost quite environ'd with the other: We cautiously therefore convey'd into some *Oil of Cloves*, whose *surface* the Vessel permitted to be large enough, some portions of *common Water* of differing bignesses, taking care, as far as we could, that they might not touch one another; by which means the Oil being transparent, and yet somewhat colour'd, 'twas easie to observe, that the smaller portions of *Water* were so near totally environ'd with the Oil, that they were reduc'd into almost perfect globes; those portions, that were somewhat bigger, (as about twice the bigness of a *Pea*,) would be of a figure somewhat approaching to that of an *Ellipsis* (for 'twas not the same)

same,) and those portions that were yet somewhat larger, though they seem'd to be sunk almost totally beneath the Oil, yet they held to it by a small portion of themselves, whose *surface* was easily enough distinguishable from that of the Oil. These larger portions of immers'd Water, being almost wholly inviron'd with the other Liquor, were by it reduc'd into a round figure, which was ordinarily somewhat *Elliptical*, but more depress'd in the middle than that figure requires. But all this is to be understood of those portions of Water, that touched only the Oil and the Air: for those that touched one another without mingling, and much more those that adher'd more or less to the sides of the Glass, had their *surfaces* too differinglly and irregularly figur'd to be here attempted to be described.

As for the *Superficial figure of Water*, contiguous, both above and beneath, to other *Fluids*, and laterally to some Solid body, 'tis not so easie to be sure, which of the contiguous Liquors is of most force to determine the figuration of their common *superficies* or *Commisfure*. But however I shall relate, that, having into a slender Pipe of that sort that has been describ'd before, put a little *Oil of Cloves*; and upon this some *Oil of Turpentine*, that so the Water might both above and beneath be touched by *heterogeneous Liquors*, I observ'd not the *Oil of Cloves* to be very manifestly tumid at the top, nor the lower surface of the *Oil of Turpentine* (for the upper was Concave) to be very Convex; for somewhat *convex* it was, downwards. And from this 'twill be easie to conclude, the *figure* of the Cylindrical portion of Water intercepted between these two Oils.

That Agent or force, whatever it be, that keeps Liquors *fluid*, does likewise, whilst they are so, keep their *surfaces* exceeding smooth, when they are contiguous to the Air and other Fluids. But because I thought it doubtful, whether even those Liquors that are (as Men usually speak) *naturally fluid*, I mean, such as are not made so by fusion, produced in them by the action of the Fire, would retain smooth surfaces when they have lost their *fluidity*, and have their parts no longer inflected and agitated, so as to enable them, by the help of *Gravity*, *Viscosity*, or both, to *levigate* (if I may so speak,) or polish each others surfaces, as it may be guess'd in their fluid state they did;

I thought it not amiss, in order to the clearing of the doubt, to make some Trials with *contiguous Liquors*, whereof one would continue fluid when the other had lost its fluidity.

I took then *Oil of Anniseeds*, thaw'd by a gentle warmth, and *common Water*, and having put them together in a conveniently shaped Glass, they were suffer'd to stand in a cold place till the Oil was coagulated; which done, it was parted from the Water, and by the roughness of its *superficies* manifested, as I expected, that, when its parts were no longer agitated and kept easily displaceable by the subtle *permeating* matter, or whatever other Agent or Cause it were, to which it ow'd its Fluidity, then the contiguous Water grew unable to inflect, or otherwise place them after the manner requisite to constitute a *smooth surface*. And what happen'd to that part of the Oils surface that was touch'd by the Water, happen'd also to that which was contiguous to the Air; save that the *asperity* of the last nam'd surface was differing from the other, which, whether 'twere an accidental or constant *Phænomenon*, further Trial must determine. But I have often observed, that the upper surface of *Oil of Anniseeds*, when this Liquor comes to be coagulated by the cold Air, was far enough from being smooth, being variously asperated by many flaky particles, some of which lay with their broad, and others with their edg'd, parts upwards.

An *inequality* and *ruggedness* of *superficies* I have also observ'd in Water, when, having cover'd it with Chymical *Oil of Juniper*, and expos'd it in very Cold weather, though the Oil continued fluid, yet the Water, being frozen, had no longer a smooth *superficies*, as whilst in its liquid state 'twas contiguous to the Oil. And the like Inequality, or rather a greater, we observed in the surface of Water frozen, which had Chymical *Oil of Turpentine* swimming over it; yet a no less, if not a much greater, roughness may be oftentimes observed in the surfaces of divers Liquors that abound with Water, when those Liquors being frozen, their *surfaces* have an immediate contact with the Air. This I, among others, (elsewhere) observed; And I shall here add, that having purposely caused a strong and blood-red decoction of the *Soot of Wood* to be exposed in a large Glass in a very Cold night, I was more pleas'd than surpriz'd, to find in the morning a Cake of
Ice,

Ice, that was curiously figur'd, being full of large flakes shap'd almost like the broad blades of Daggers, but neatly fringed at the edges. But that which I chiefly mention these Figures for, is, that they seem to be as it were imboist, being both to the Eye and the Touch rais'd above the Horizontal plain or level of the other *Ice*.

And here I must not omit to take notice, that whereas in the recited Experiments the rugged surface was produced at the Confines of two *heterogeneous* and unfociat- Exp.XXII. ble Liquors, I have sometimes observed the like

Phænomenon in one and the same Liquor, and particularly, not long since looking in Frosty weather on a Viol where I had long kept *Oil of Vitriol*, I perceived, that the Cold had reduced far the greatest part of the *Menstruum* into a consistent Mass, whose upper surface was very rugged and oddly figured, though it lay cover'd all over with a pretty deal of high colour'd Liquor, that was not frozen or coagulated, nor seem'd disposed to be so, at least in that degree of Cold.

This brings into my mind, that not only Bodies, which in their Natural state (as 'tis wont to be call'd) are *fluid*; but also such, as, by the violence of the fire, are Exp.XXIII. made to flow, may be conformable to some naturally

Fluid bodies in their superficial Figures. This may be observ'd in the best sort of what the Chymists call *Regulus Martis stellatus*, where the figure of a Star, or a figure somewhat like that of the *Decolition of Soot* lately mention'd, will frequently appear imboist upon the upper *superficies* of the *Regulus*; and such a rais'd Figure I think I can yet shew you, on a Mass of *Regulus* made of *Antimony* without *Mars*. But if, to those two bodies, *Copper* be also skilfully added, the *Superficies* will be oftentimes adorned with new Figures according to Circumstances; though the most usual I took notice of was that of a Net, that seem'd to cover the surface of the compounded *Regulus*. But this is not so constant, but that I have by me a Mass of a *Conical figure*, consisting of two very contiguous, but easily separable, parts, whereof the lowermost, which abounds more in Metal, hath its upper surface cover'd with round *protuberances*, in shape and bigness not unlike to small *Pease* cut in two; and these are so really imboist and elevated above the rest of the *superficies*, that the other part of the Cone, which is of a more

scorious Nature, has, in its lower surface, which exactly fits the upper of the *Regulus*, Cavities, for number, shape and bigness, answering to the *protuberances* lately mention'd; which argues, that the *Regulus* cooled first with that Inequality of surface we have describ'd, and that the lighter and more Recrementitious substance, continuing longer fluid, had thereby opportunity to accommodate it self to the superficial Figure of the *Regulus*, on which it first lean'd, and was afterwards coagulated.

So far of this Sequel at the present ; what remains may be expected at the first conveniency.

An Account of two Books :

1. *PALÆOLOGIA CHRONICA: A Chronological Account of Ancient time: In Three parts; Didactical, Apodeictical, Chronical.* By Robert Cary, D.L.L. Devon. London, 1677. in fol.

THe Design of this elaborate Work seems to be, to determine the just interval of Time between the great *Epocha* of the *Creation of the World*, and that other of the *Destruction of Jerusalem* by *Titus Vespasian*, in order to the assignment of such particular *Time*, wherein Persons and Actions of old had their Existence. For the performance of which, the Learned Author divides this his Book into *three* main parts.

In the *first* he treats not only of his Measure in general, which is the *Year*, and its parts; but also of the *Julian Year* in particular, by him esteem'd the fittest for his Use: considering it both in it self, and in relation to other the most received kinds, for the reducing of them to this. Where comes in the *Julian Period*, of which he discourses very fully; shewing *first*, How it is made up, *viz.* by the Multiplication of the Cycles of the *Sun*, *Moon*, and *Indiction* into one another, as 28 into 19, and the product thereof into 15, which produces 7980, the *Julian Period*, so called, because accommodated to the *Julian Year*; the ground whereof was taken from the Ancient Greek Church, perfected and promoted in this later Age by *Jos. Scaliger's* dexterity. *Secondly*, What the contrivance is of this *Julian*.